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DEPARTMENTS.

SOLUTIONS OF PROBLEMS.

ALGEBRA.

298. **Proposed by W. J. GREENSTREET, Marling School, Stroud, England.**

Find an approximation to the difference between the sums of n harmonic and n arithmetic means between a and b, when a is very nearly equal to b.

Solution by A. H. HOLMES, Brunswick, Me., and J. SCHEFFER, A. M., Hagerstown, Md.

n arithmetic means between a and b would be:

$$\frac{an+b}{n+1},\ \frac{a(n-1)+2b}{n+1},\ \frac{a(n-2)+3b}{n+1},\ \ldots,\ \frac{a+nb}{n+1}.$$

Putting S_1 for the sum of these terms, we find $S_1=\frac{(a+b)n}{2}$.

n harmonic means between a and b would be:

$$\frac{ab(n+1)}{a\,(n+1)+(b-a)},\ \frac{ab(n+1)}{a\,(n+1)+2(b-a)},\ \ldots,\ \frac{ab(n+1)}{a\,(n+1)+n(b-a)}.$$

Putting S_2 for the sum of these n terms we find, disregarding powers of $(b-a)$ above the third since a nearly equals b,

$$S_2=nb\left[1-\frac{b-a}{2a}+\frac{(2n+1)\,(b-a)^2}{6a^2(n+1)}-\frac{n(b-a)^3}{4a^2\,(n+1)}\right].$$

$$\therefore S_1-S_2=n\left[\frac{a+b}{2}-b\left(1-\frac{b-a}{2a}+\frac{(2n+1)\,(b-a)^2}{6a^2(n+1)}-\frac{n(b-a)^3}{4a^2\,(n+1)}\right)\right]$$

$$=n\left[\frac{a-b}{2}+\frac{b}{a}\left(\frac{b-a}{2}\right)-\frac{b(2n+1)\,(b-a)^2}{6a^2(n+1)}-\frac{nb\,(b-a)^3}{4a^2\,(n+1)}\right]$$

$$=\frac{n}{2a}(a-b)^2\text{, nearly.}$$

Also solved by G. B. M. Zerr, T. I. Wodo, and H. V. Spunar.